in the quarterly bulletin of the Iowa State Board of Health (Vol. XXV, No. 2), is of interest:

Microscopic examinations of 22 common drinking vessels from public places were made. The vessels were obtained from two different cities in Iowa, in one of which there were a large number of cases of diphtheria. The vessels were obtained from the following kinds of places: six from hotels, 1 from a courthouse, 1 from a cigar store, 1 from a railway car, 12 from public schools, and 1 from a public well.

The following represents the kinds of disease-producing bacteria and the number of cups on which such were found: Diphtheria bacilli on 2 (both cups were from schoolhouses of a city in which there were a large number of cases of diphtheria); pus-producing bacteria on 17; pneumococci (the germs of pneumonia) on 3; micrococcus catarrhalis (the germ which frequently produces colds) on 7. In addition, 7 of the cups contained epithelial cells and mucus from the mouth.

The Iowa State Board of Health at a meeting held in October, 1911, adopted the following regulation:

Whereas it has been demonstrated that common drinking cups are frequently contaminated with disease-producing germs and, as a medium for the transmission of contagious and infectious diseases, they are a source of danger to the public health; and

Whereas individual or private drinking cups may readily be provided in such places where most needed: Therefore,

Under the authority of the statute imposed upon the State board of health to promulgate rules and regulations relative to the preservation of the public health in contagious and infectious diseases and the prevention of the same, the use of the common drinking cup in all public places such as parks, streets, schoolhouses, hotels, factories, workshops, libraries, railway stations and cars, and all other public places is hereby prohibited from and after January 1, 1912.

INVESTIGATIONS OF AND TICK ERADICATION IN ROCKY MOUNTAIN SPOTTED FEVER.

A REPORT OF WORK DONE ON SPOTTED FEVER IN COOPERATION WITH THE STATE BOARD OF HEALTH OF MONTANA.

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INTRODUCTION.

Rocky Mountain spotted fever has prevailed in Montana and Idaho for at least several decades. The earliest available record of the disease having been reported was in the year 1873. Cases of the disease have from time to time occurred in other States until now Rocky Mountain spotted fever has been reported from practically all of the Rocky Mountain States, including Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming.

Although the disease is far more prevalent in Montana and Idaho than in any of the other States, its spread has assumed such proportions in the last decade as to call for the gravest consideration on the part of both the State and national health authorities. In fact, the disease has so spread from State to State that it has undoubtedly become a very serious interstate problem demanding the institution of measures for its control and suppression. There is, however, a marked variation in the severity of the disease in different localities, notably in Montana, as compared with Idaho. Particularly in the Bitter Root Valley in Montana the mortality rate is very high, while in Idaho it is comparatively low.

The reason for this variation in severity still remains an unsolved problem. On account of its persistent seasonal prevalence and

severity the disease has become a very serious public health and economic problem in the Bitter Root Valley, where, in addition to the lives that are annually sacrificed, very valuable agricultural lands have depreciated in value and in certain localities have been almost abandoned on account of the fear and dread that the inhabitants have of Rocky Mountain spotted fever.

For several years the State Board of Health of Montana has been carrying on a campaign of investigation with the purpose in view of eradicating, if possible, the disease from that State. It has had the services of such workers as Wilson and Chowning of the University of Minnesota; Ashburn, Craig, and Keifer of the Army; Cobb, Anderson, Stiles, Francis, and King of the Public Health and Marine-Hospital Service; and, finally, Ricketts and his associates.

The State Legislature of Montana early in 1911 made an appropriation for continuing the work for a period of two years, and at the request of the State board of health, through its secretary, Dr. T. D. Tuttle, the work was again taken up by the Public Health and Marine-Hospital Service in May, 1911. It at once became evident that the rational lines along which the work should be carried were in accordance with those laid down by Dr. H. T. Ricketts. While the appropriation available was not large enough to allow the taking up of the work on an extensive scale, nevertheless it was apparently sufficient, exclusive of the officers' salaries which were paid by the Treasury Department, for determining or making a demonstration as to the feasibility of eradicating the tick, *Dermacentor andersoni* Stiles, the real causative agent concerned in the transmission of Rocky Mountain spotted fever. It was therefore decided to select a limited area in one of the worst infected territories and to put into operation the best-known measures for the eradication of the tick. It was also considered advisable to continue Ricketts's work of testing the susceptibility of the wild mammals to experimental inoculation with spotted fever and to search for the infection of that disease among the wild mammals in nature.

Accompanied by Dr. Tuttle, I arrived in the Bitter Root Valley the latter part of May, and after looking over the situation in the valley it was decided to carry on the work in the vicinity of Victor, Mont. An infected territory of about 8 square miles was selected about 3 miles from Victor. It is situated in the foothills of the mountains on the west side of the valley and has its boundaries rather well defined on the north and south by Sweathouse Creek and Bear Creek, respectively. In this territory the ticks are found in large numbers during the tick season, and many cases of spotted fever have been reported from there during past years; in fact this territory has been almost depopulated because of the presence of spotted fever. From this district Ricketts, during the season of 1908, collected ticks with which he was able to infect guinea pigs.

As most of the cases of spotted fever occur in the Bitter Root Valley during the months of April and May it will be seen that the latter part of May was very late in the season to begin the work. It was decided, however, that a start should be made and that the work could again be taken up at the beginning of the tick season of the next year. The ticks begin to decrease in number during the month of June, and by the first of July they have largely disappeared. Throughout most of the year it is, however, possible to find, from time to time, a few ticks in certain localities.

The work was carried on at Victor until August 7, when it was transferred to the Hygienic Laboratory at Washington, where the laboratory side of the work was continued.

About the middle of June, Passed Asst. Surg. W. C. Rucker was detailed to assist in the work.

As the State of Montana made the appropriation for conducting this investigation, the work is being done in conjunction with the State board of health. Dr. T. D. Tuttle, secretary of the board, has heartily cooperated in every way possible and in an advisory capacity has rendered valuable service in outlining the work and in furthering its success.

The studies of Dr. Ricketts on spotted fever have been of the greatest value, and it has been endeavored to take up the work where he left off and to continue it by putting into effect his plans and recommendations.

The work as contemplated, and as carried on, may be embraced under two general headings as follows:

1. The eradication of the tick.
2. Laboratory investigations.

ERADICATION OF THE TICK.

Ricketts and others having fully established the important rôle played by the tick, *Dermacentor andersoni*, in the transmission of Rocky Mountain spotted fever, it is at once evident that measures for the suppression and prevention of the disease must necessarily be directed along the line of the eradication of the tick.

As the seasonal prevalence of the tick is largely limited to the months of March, April, May, and June, that season is usually known as the "tick season" in the Bitter Root Valley. During the remainder of the year the tick is found only sparingly and the occurrence of cases of spotted fever is consequently rare during this time. On the other hand, during the tick season, particularly in April and May, the tick is found in large numbers, and considering the general topography of the valley and bearing in mind that the disease is found from the foothills to the top of the mountains, it will be seen that its complete eradication from the Bitter Root Valley is an impossible undertaking. The valley is about 100 miles long and is formed by two ranges of the Rocky Mountains that in places reach an altitude of eight to nine thousand feet. The ranges bounding the valley are intersected at intervals by deep gorges or canyons and the mountains in places are very precipitous and almost impassable. While the valley narrows down to a deep gorge toward its southern extremity, throughout most of its length it varies in width from a few miles to about 25 miles.

The tick is seldom found on the cultivated lands of the valley, but is largely restricted to the forested foothills and mountains. Both in point of numbers and variety of species the fauna of the valley is excelled by very few other localities of similar size in the United States, and most of the mammals, both wild and domestic, harbor the tick in one form or another. It is therefore evident that the dipping of the domestic stock alone will not eradicate the tick from the valley completely. There is no doubt, however, that it will greatly reduce the number of ticks, and in consequence will both minimize the chances of inhabitants becoming infested with ticks

and of ticks being carried to the vicinity of, or into, dwellings by persons or domestic animals.

The measures put into force for the eradication of the tick in the infected territory selected for demonstrative purposes were as follows:

A. Dipping of the domestic animals known to harbor the tick.

B. Killing of the wild mammals.

DIPPING OF DOMESTIC STOCK.

An area of about 8 square miles conveniently located in the infected territory was selected. In this area a dipping vat was constructed. The vat was made of concrete according to the plans given in Farmers' Bulletin No. 378.[1] It has a depth of 9 feet and is about 38 feet long at the water line. When using the vat it is filled with dipping fluid to a depth of 5 feet 5 inches. With this depth of fluid, all of the stock, with the possible exception of a few large horses, are completely immersed upon going down over the slide. The slide was first constructed of concrete, but as it did not become smooth, a boiler-metal slide was later installed. The cost of construction of the vat, including corrals, dripping pens, etc., was about $520. The dipping fluid used is an arsenic preparation, recommended by the Bureau of Animal Industry, Department of Agriculture, and sold under the commercial name of "Tixol." It is used diluted with water to a strength of 1 per cent. The quantity of liquid required to fill the vat to a depth of 5 feet 5 inches is about 2,500 gallons. The construction of the vat was completed June 14 and the dipping of domestic stock begun at once.

The following stock was then dipped:

Horses	116
Cattle	199
Sheep	108

After an interval of about two weeks, on July 3 the redipping of the stock was begun, but as the stock, upon examination, was found to be practically free from ticks the dipping was discontinued after the following stock had been redipped:

Horses	38
Cattle	57
Sheep	60

There were no untoward results following the dipping of the stock in the arsenic dipping fluid, except that one young bullock later showed a marked peeling of the skin. I was informed by the State veterinarian, Dr. Knowles, that this was not a result of the animal having been dipped. The animals were driven to the vat and allowed to remain in the corrals for a half hour or more before they were dipped. After they were dipped they were kept in the corrals until they became dry. It was found necessary to employ the services of a competent man to bring the stock to the vat when the owners were too busy to do so. This will frequently be found to be the case, particularly during the farmer's busy season. Furthermore, considerable difficulty is sometimes encountered in corralling and driving the stock into the vat and consequently the services of a man familiar with the handling of stock are necessary in this capacity.

[1] H. W. Graybill, Farmers' Bulletin 378, Department of Agriculture, 1909.

Most of the stock owners are willing to have their stock dipped, but a few, as is usually the case in undertakings in the interest of the public health, object to having anything done that causes any inconvenience or work. In this case their objection is usually based on the argument that their stock does not need dipping, or that they do not believe in the tick as a transmitter of spotted fever. To obviate this difficulty a State law should be passed compelling all persons to have their stock dipped in the interest of the public health.

KILLING OF WILD MAMMALS.

It is already known that some of the wild mammals found in the Bitter Root Valley are susceptible to experimental inoculation with spotted fever, while the question as to the susceptibility of the others has not yet been determined. It is also a fact that many of the wild mammals found there harbor the tick in one form or another, so that the killing of these animals serves a twofold purpose.

The ground squirrel (*Citellus columbianus*), commonly known as the "gopher" or "picket-pin," is the predominating animal found in the Valley. This animal is susceptible to experimental infection with spotted fever and is often found harboring the larval and nymphal forms of the tick in large numbers. Its seasonal prevalence coincides rather closely with that of the tick. It goes into hibernation about the first of August, while the tick has largely disappeared by the first of July.

The campaign of destruction of the wild mammals was waged principally against the ground squirrel (*Citellus columbianus*), the pine squirrel (*Sciurus hudsonicus richardsoni*), the yellow-bellied chipmunk (*Eutamias b. luteiventris*), the wood rat (*Neotoma cineria*), the woodchuck (*Marmota flaviventor*), the weasel (*Putorius arizonensis*), and the badger (*Taxidea taxus*).

The methods of killing these animals consisted of shooting, trapping, poisoning, and the use of carbon bisulphide placed in the burrows of the animals. A force of from three to five men was employed in carrying on this work of animal extermination. About 100 to 150 small traps were used. These were set in the burrows of the animals. After the traps had been set for a while and most of the animals caught, the traps were then moved to other burrows and poison (poisoned wheat) placed in the burrows from which the traps were removed. Only 25 gallons of carbon bisulphide were used, but it proved very efficient in killing all mammals that live in burrows. It was used by simply saturating a ball of waste or other material with the liquid and then placing it in the burrow of the animals, after which the mouth of the burrow was closed with a piece of sod or some earth. After all the communicating burrows have thus been treated and closed the carbon bisulphide gas can be exploded, if so desired, by touching a match to the mouth of one of the burrows in which the carbon bisulphide has been placed. It appeared, however, that its efficiency was increased by not exploding the charge, the gas itself being deadly to animal life.

The work of killing wild mammals was begun June 7 and discontinued August 5, during which time the following animals were either shot or trapped in the district selected for carrying on the work:

Ground squirrels (*C. columbianus*)	3,233
Pine squirrels (*Sciurus h. richardsoni*)	109
Chipmunks (*Eutamias b. luteiventris*)	94
Wood rats (*Neotoma cineria*)	7
Woodchucks (*Marmota flaviventor*)	1
Weasels (*Putorius arizonensis*)	16
Badgers (*Taxidea taxus*)	5
Total	3,465

The above does not of course include the animals killed with poison or carbon bisulphide, it being impracticable to determinine the number killed by either of these processes.

The following table shows, by weeks, the number of ground squirrels killed by shooting and trapping during the season:

Week ended—	Number of squirrels.	Week ended.	Number of squirrels.
June 10	275	July 15	450
June 17	584	July 22	371
June 24	401	July 31	196
July 1	454	Aug. 5	83
July 8	419		

A glance at the above table will show how the ground squirrels begin to disappear about the middle of July and that by the 1st of August most of them have gone into hibernation.

Unfortunately in waging a campaign of extermination of ground squirrels by shooting and trapping the operator is very much at the mercy of the weather as the squirrels are not inclined to come out of their burrows during inclement or bad weather. Therefore, for purposes of extermination in the future, it is proposed to rely principally upon the use of poison and carbon bisulphide, particularly the latter. During the early season in the Bitter Root Valley, poison and carbon bisulphide can be used, however, to much better advantage for killing mammals that live in burrows than they can later in the season after the green vegetation appears. Naturally, after the vegetation comes out, food becomes plentiful and the animals are not inclined to take the poisoned grain as readily as they do early in the season when food is scarce. Furthermore, after the dense grass, etc., has appeared it is difficult to find all the burrow openings when using carbon bisulphide.

OTHER METHODS THAT MAY BE UTILIZED IN ERADICATING THE TICK.

HAND TREATMENT OF DOMESTIC STOCK INFESTED WITH TICKS.

This should be permissible only in case the use of the dipping vat is not available or under certain circumstances where there are only a small number of gentle stock to be treated, such as, say, a horse and a cow or two. In that case the stock should be carefully searched for ticks every three or four days, or an arsenical dip may be applied by means of a spray, cloth, or otherwise, at least once every 7 days. The principal difficulty in using a dipping fluid by hand is that the ticks are usually found on the under surfaces of the animals where it is more or less difficult to efficiently apply the dipping fluid by hand methods.

BURNING.

There is no doubt that a great many ticks are destroyed by the forest fires that sometimes sweep over the mountains of the Bitter Root Valley. It is largely the immature forms or "seed ticks" that are destroyed, as the fires usually occur in the fall of the year, when it is supposed that most of the ticks are in the transition stage. The forest fires also consume a great deal of débris and undergrowth in which the ticks apparently find conditions most favorable for their protection and life preservation. A great deal could therefore be accomplished in tick eradication by a systematic burning of the mountains every autumn. The practicability of putting such means into effect, however, will have to be left to the opinion and judgment of experts on forest fires. Most of the mountainous land in the Bitter Root Valley belongs to the Forest Reserve, the care of which is under the jurisdiction of the Bureau of Forestry. Forest fires are often hard to control and sometimes cause loss of life. They also destroy a certain amount of valuable timber, but provided the fires can be kept under control the loss through the destruction of timber in the Bitter Root Valley will be small as compared with the loss of life from spotted fever and the depreciation in value of the agricultural lands on account of the presence of that disease. Burning over the foothills early in the spring of the year after the snow melts would destroy a great many ticks and would not endanger property, as the fire then burns slowly and could be controlled. The snow in the mountains would prevent the fire from extending there. The burning, however, should be carried on under the supervision of experts from the Bureau of Forestry, who are familiar with the management and control of forest fires.

CLEARING.

There is a large quantity of tillable land on the west side of the Bitter Root Valley that is not under cultivation. Some of it is still covered with virgin forest, while a portion of it is covered with dense shrubbery and undergrowth. It is on land of this character that the tick is found in greatest numbers, the vegetation seeming to afford it protection. The tick is seldom found on land under cultivation; consequently the clearing and cultivation of the land referred to would practically eradicate the tick therefrom. Of course the clearing of this land should not be attempted during the tick season, but during the other portion of the year when the danger of infection by the tick would be reduced to a minimum.

LABORATORY INVESTIGATIONS.

A STUDY OF THE SUSCEPTIBILITY OF CERTAIN MAMMALS TO EXPERIMENTAL INFECTION WITH ROCKY MOUNTAIN SPOTTED FEVER.

Ricketts worked on the susceptibility of some of the wild mammals in the Bitter Root Valley to infection with spotted fever and proved conclusively that at least several of the species found there are susceptible to experimental infection with that disease. By inoculation with the virus of spotted fever (i. e., blood from an animal, usually the guinea pig, sick with the disease, about the third day of the animal's

fever) he was able to infect the ground squirrel, woodchuck, rock squirrel, chipmunk, and mountain rat. With the exception of the mountain rat, he was successful in infecting those animals by the bites of infected ticks, and completed the "tick cycle" in the case of the ground squirrel, woodchuck, rock squirrel and probably the chipmunk. He used the term "tick cycle" to indicate the infecting of an animal by the bite of an infected tick and then the infecting of a fresh tick from the animal so infected.

Although some of the wild mammals in the Bitter Root Valley are known to be susceptible to infection with spotted fever, when they are inoculated with the virus they usually have the disease in such mild form that it is almost unrecognizable from the symptoms produced. Therefore, practically the only reliable method of diagnosing the infection in the mammals referred to consists in the inoculation of blood from the suspected animal into a highly susceptible animal such as the guinea pig, and noting the results in the latter animal.

The rôle, if any, that the wild mammals play in the existence of the infection from year to year or in the spread of the disease has not yet been determined, as the disease has never been found in any of the wild mammals in nature. Practically no pathological lesions are found on post-mortem examination of these animals, even when they are known to be infected with spotted fever.

For the purpose of determining whether or not spotted fever prevails among the wild mammals in nature, it appears that about the only way in which the problem can be approached is through (*a*) a search for the infection in mammals from infected districts by inoculating their blood into guinea pigs, and (*b*) a study of the immunity and susceptibility of mammals from infected districts as determined by inoculating them with the virus of that disease and later making inoculations of their blood into guinea pigs. In the latter case it is assumed, since it has been fairly well established, that an attack of spotted fever in a susceptible animal renders the animal immune to further infection with the disease. For instance, a ground squirrel is susceptible to infection with spotted fever, either by the bites of infected ticks or by inoculation, but it would not be found susceptible to further infection with that disease provided it had already had the disease in nature. The work was undertaken along the lines indicated above. Some work was also done on the neutralizing powers of the blood of some of the wild mammals as determined by mixing it with the virus of spotted fever and injecting the mixture into guinea pigs. Success in this field, however, is handicapped by the fact that even though an animal has had spotted fever and been thus rendered immune the antibodies produced in the blood of the animal do not remain there indefinitely.

THE GROUND SQUIRREL (C. COLUMBIANUS).

The ground squirrels used in this work were captured by the force of men employed in carrying on the campaign of wild mammal extermination in the territory selected for demonstrative purposes. The ground squirrels, therefore, came from a district supposed to be badly infected with spotted fever. As most of the animals were caught in traps they were all more or less injured about the feet and

legs. This, of course, was of no consequence provided the animal's blood was simply to be taken and injected into guinea pigs, but when the squirrels were to be injected with the virus of spotted fever it was necessary to keep them until they had recovered from their injuries before they were inoculated.

Search for the infection of spotted fever among the ground squirrels in nature.—The men carrying on the campaign of wild mammal extermination were furnished with clinical thermometers and directed to take the temperature of all live ground squirrels at the time they were captured. They were also instructed to examine the animals closely for abnormal appearances or conditions and to forward all suspects to the laboratory. Unfortunately the temperature of the ground squirrel does not furnish a reliable index as to whether or not it is infected with spotted fever. It was found that a ground squirrel, after being trapped and left in the hot sunshine for awhile, might show a temperature of 110° F., which, when the animal was removed to the shade, might drop as much as 10 degrees in the course of an hour. Under these conditions the temperature of ground squirrels was found to vary from 95° F. to 110° F.

Ricketts had observed this variability in the temperature of both the healthy and infected ground squirrel, and in order to determine whether or not a ground squirrel was infected with spotted fever after it had been inoculated with the virus of that disease, he found it necessary to make an inoculation of the blood from the squirrel into a guinea pig. In the absence of either ante-mortem or post-mortem lesions or evidences characteristic of spotted fever in the ground squirrel this is apparently the only method that offers any hope of success of finding the infection among them in nature. As the ground squirrels used for this purpose have to be selected more or less at random, the work naturally will have to be taken up and done on a large scale before any definite conclusions can be arrived at. This, of course, necessitates the use of a large number of guinea pigs, which are obtained with difficulty in Montana.

It was impossible to carry the work on to any extent during the season of 1911. Blood from only 21 ground squirrels was injected into a corresponding number of guinea pigs. The ground squirrels were selected on account of their harboring a large number of ticks, or their having an extremely high or low temperature, or their showing some condition that seemed abnormal.

The quantity of ground-squirrel blood that was injected into the guinea pigs varied from 2 c. c. in some cases to 4 c. c. in others. The blood was usually taken from the heart of the ground squirrel and injected intraperitoneally with 2 c. c. of normal saline solution. The temperatures of the guinea pigs were then taken every day for about two weeks. None of the pigs injected from the 21 squirrels showed any evidences of spotted fever, although they all developed it when later they were given an immunity test with the virus of that disease. This work thus proved negative so far as finding the infection in ground squirrels is concerned.

The susceptibility of the ground squirrel to spotted-fever infection.—The ground squirrels were caught and kept in captivity until they had recovered from the injuries caused by the traps. They were then inoculated intraperitoneally with the virus of spotted fever. Their temperatures were taken each day, and at the end of definite periods

inoculations of their blood were made intraperitoneally into guinea pigs. The blood for this purpose was usually taken from the heart of the squirrel by means of a syringe. Many of the squirrels died as a result of the heart puncture. No lesions characteristic of spotted fever could be found in any of them on post-mortem examination, although the injection of their blood into guinea pigs usually produced spotted fever in the pigs. The same irregularity in the temperature range of the ground squirrels was observed after they were inoculated with the virus of spotted fever, as was observed in them before they were inoculated, usually ranging from 100° F. to 104° F.

The following table shows the results of inoculating guinea pigs with blood of ground squirrels which had previously been inoculated with the virus of spotted fever:

No. of squirrel.	Amount of virus inoculated.	Duration from date of inoculation.	Blood from squirrel to pig.	No. of guinea pig.	Result in guinea pigs.
	c. c.	*Days.*	*c. c.*		
26	1.0	7	2.0	75	Positive,[1] died.
27	1.0	5	2.5	118	Do.
28	1.0	5	1.5	119	Do.[1]
29	1.0	5	1.0	120	Do.
30	1.0	5	1.0	121	Do.
31	1.0	5	1.5	122	Do.
32	1.0	5	1.0	123	Do.
33	1.0	5	1.0	124	Do.
34	1.0	5	1.0	125	Do.
35	1.0	5	1.5	126	Positive, moribund, killed.
36	1.0	5	1.0	127	Do.
37	1.0	5	1.0	128	Positive, died.
38	1.0	5	1.5	129	Do.
51	1.0	5	.5	155	Positive, moribund, killed.
52	.5	5	.5	156	Do.
53	.5	2	.5	149	Negative.[2]
54	1.0	5	.75	157	Positive, died.
55	.5	5	.75	158	Questionable.[3]
57	1.0	5	.75	159	Positive, moribund, killed.
65	.5	6	.5	299	Positive, died.
66	.5	12	.5	306	Negative.
		6	.5	300	Positive, died.
		12	.5	307	Positive, recovered.
67	.5	6	.5	301	Positive, died.
68	.5	6	.5	302	Do.
69	.5	6	.5	303	Positive, recovered.
70	.5	12	.5	308	Negative.
		5	.5	388	Positive, died.

[1] Positive, means that the guinea pig ran the temperature and showed the lesions that are considered typical of spotted fever.

[2] Negative, means that the guinea pig did not have spotted fever as proven later when it was given the immunity test.

[3] Questionable, means that there was doubt as to whether or not the guinea pig had spotted fever.

That the blood taken from ground squirrel No. 53 on the second day after its inoculation with the virus did not infect the guinea pig, as was proven later when the guinea pig was given the immunity test, is not positive proof that the ground squirrel was immune to spotted fever. Nonimmune guinea pigs do not invariably develop the disease when they are injected with the virus, but the negative result in question is probably due to the early date in the period of incubation at which the blood was taken from the ground squirrel.

The result with ground squirrel No. 55 is in doubt, since the guinea pig did not run the temperature or show signs typical of spotted fever either following its injection with blood of the ground squirrel or later when it was given the immunity test. It is probable, however, that

it had a mild attack of spotted fever and was thus rendered immune as a result of its injection with the blood of the ground squirrel.

Blood taken on the sixth day from ground squirrels Nos. 65, 66, and 69 was infective for guinea pigs, but it was not infective for them at the end of 12 days except in the case of ground squirrel No. 66. These results are in rather close accord with Ricketts's findings, namely, that the blood of ground squirrels experimentally infected with spotted fever is not usually infectious for guinea pigs after the twelfth to the fifteenth day. It will be observed that nearly all of the ground squirrels tested were definitely proven to be susceptible to experimental infection with spotted fever as shown by the results in guinea pigs. This is rather contrary to expectations, in view of the fact that all of the ground squirrels came from a district supposed to be badly infected with spotted fever, and since that animal is known to be susceptible to infection through the bite of the infected tick.

As more or less of a control for the work along this line two experiments were done with ground squirrels that had recovered from spotted fever. Ground squirrels Nos. 27 and 31 were experimentally infected with spotted fever as is shown above. About seven months after they were thus infected they were again inoculated with the virus and five days later inoculations of their blood were made into guinea pigs Nos. 384 and 385, respectively. Both of the guinea pigs remained well until they were given the immunity test a month later from which they both developed spotted fever. These results thus indicate that these two ground squirrels were immune to spotted fever after a lapse of seven months.

Further work during the next season on the immunity of ground squirrels from other infected districts is contemplated.

The protective or neutralizing properties of the blood of immune ground squirrels.—Ricketts having found that the blood of the ground squirrel recently recovered from spotted fever has rather marked neutralizing powers when mixed with the virus of that disease and injected into guinea pigs, some work was done along this line with blood from 30 ground squirrels that were caught in the infected district. The blood was defibrinated and quantities varying from 0.5 c. c. to 2 c. c. were mixed with 0.5 c. c. or 1 c. c. of virus of spotted fever. After mixing the blood and virus it was immediately injected into guinea pigs. A total of 35 guinea pigs were thus utilized, 2 of them being used in each case of 5 ground squirrels. The results will not be given in tabular form, as the blood from the ground squirrels did not apparently protect any of the guinea pigs in the least against infection with spotted fever. Of the 35 guinea pigs thus utilized 27 died of spotted fever, while the remainder had well-marked cases of that disease but recovered.

In connection with this work some experiments were done with the blood of three ground squirrels which, 100 days previously, had been immunized against spotted fever; that is, their infection with that disease was proven. They were ground squirrels Nos. 34, 37, and 38 (see p. 741).

The following table will show the results of mixing the blood of the ground squirrels with the virus of spotted fever and injecting the mixture into guinea pigs:

No. of squirrel.	Quantities mixed.		Injected into pig No.—	Result in guinea pig.
	Squirrel blood.	Virus.		
	c. c.	c. c.		
34	0.5	0.5	258	Pig protected; immunity test, pig died of spotted fever.
	1.0	.5	259	Do.
37	.5	.5	260	Pig died of spotted fever.
	1.0	.5	261	Pig had medium case of spotted fever; recovered.
38	.5	.5	262	Pig had mild case of spotted fever; immunity test, negative.
	1.0	.5	263	About same as pig 262.
Control..	2.0	.5	264	Pig died of spotted fever.

These experiments simply show that the blood of the ground squirrel recently recovered from spotted fever has some power for neutralizing the virus of that disease when the two are mixed together, and that it remains, partly at least, in the blood of the ground squirrel for a few months. They also show that this neutralizing or protective power varies in different ground squirrels.

One conclusion, however, which may be drawn from the preceding work on the immunity and susceptibility of the ground squirrel to spotted fever is that the best method of searching for immune ground squirrels in nature is by inoculating them with the virus of that disease and subsequently making inoculations of their blood into guinea pigs.

THE BADGER (TAXIDEA TAXUS).

The susceptibility of the badger to spotted fever infection by inoculation was tried in a few cases. This animal is not found abundantly in the Bitter Root Valley, and during the season only four of them were obtained alive. They were inoculated intraperitoneally with virus obtained from the guinea pig. Before the badgers were inoculated their temperatures were taken on several successive days in order to determine the normal temperature of the badger. It was found to vary considerably from day to day, as much as from 98° F. to 102.6° F., the normal apparently being about 100° F. to 101° F. After the badgers were inoculated with the virus their temperatures were taken daily and at the end of certain intervals blood was withdrawn from their hearts by means of a syringe and injected into guinea pigs. As a result of injecting the badger with the virus of spotted fever the temperature range of that animal did not seem to vary from the normal, and consequently its temperature, like that of the ground squirrel, apparently does not furnish a reliable index as to whether or not the animal is infected.

The results of inoculating badgers with the virus of spotted fever and the subsequent injection of their blood into guinea pigs are shown in the following table:

No. of badger.	Quantity of virus injected.	Duration from date of inoculation.	No. of guinea pig.	Quantity of blood.	Result in guinea pig.
	c. c.	*Days.*		c. c.	
1.....	7	7	71	2.0	Negative.[1]
			72	3.0	Do.
2.....	10	5	130	1.0	Do.
			131	0.75	Do.
		8	145	0.75	Do.
		10	152	1.0	Do.
3.....	6	5	132	1.5	Do.
			133	1.0	Do.
		8	146	0.5	Do.
			147	1.5	Positive.[2]
		12	162	0.75	Negative.
4.....	2	4	163	1.0	Do.
		7	167	0.5	Do.

[1] Negative means that the pig did not develop spotted fever.
[2] Positive means that the pig developed spotted fever.

It will be observed that of the thirteen guinea pigs which were inoculated with blood from the badgers only one of them (No. 147) developed spotted fever. This guinea pig died of spotted fever, the diagnosis of which was confirmed by injecting 0.5 c. c. of its blood into a fresh guinea pig which also developed the disease, but recovered. The negative results with the other 12 guinea pigs were later verified, except in the case of guinea pig No. 145, which died of pneumonia on the 15th day, by giving them the immunity test with the virus from which they all developed typical cases of spotted fever. It is worthy of note that although guinea pig No. 146 was injected with 0.5 c. c. of blood from badger No. 3 at the same time that guinea pig No. 147 was injected with 1.5 c. c. of blood from the same badger, it did not develop spotted fever. It is possible, however, that the blood of a larger percentage of the badgers would have been found infective for guinea pigs if the inoculation of guinea pigs had been done oftener or if a larger quantity of blood had been given them than was the case in the above experiments.

Prior to inoculating the badgers with the virus of spotted fever, some blood was withdrawn from their hearts in order to test its immunizing power for the virus of that disease. This was done by mixing definite quantities of the blood, 1 to 2 c. c., with the virus, usually 0.5 c. c., and then injecting it into guinea pigs. This experiment was repeated with the blood of badger No. 3 about one month after the badger had been injected with the virus. This was done in view of the fact that guinea pig No. 147 had been infected with spotted fever from this badger. In no case, however, did the badger blood that was mixed with the virus appear to give the guinea pigs any protection, as they all developed spotted fever of about the same severity as did the controls which were guinea pigs that were given nothing but the virus.

Although the above results with badger No. 3 undoubtedly show that the badger may possibly be experimentally infected with spotted fever, the infection is apparently so slight and infrequent as to prac-

tically eliminate that animal from the probability of playing any part in keeping the infection alive or of spreading the disease in nature.

As the badgers used in these experiments came from the Bitter Root Valley, it can not be positively stated that they had not previously had spotted fever, by which they were rendered immune to further infection with the disease. This, however, is thought highly improbable, as the tick, *Dermacentor andersoni* Stiles, has never been observed feeding on the badger.

THE COYOTE (CANIS LESTES).

Five coyotes that had been captured in the valley during the previous winter were obtained for experimental purposes. Their susceptibility to experimental infection with spotted fever was tested in the usual way by intraperitoneal injections of the virus and subsequent inoculations of their blood into guinea pigs.

The blood of the coyote is rather toxic for guinea pigs, and usually some of them die of peritonitis, pericarditis, etc., following their injection with blood of the coyote.

The temperature of the coyote was found to be quite variable from day to day, the normal being about 101° F. to 102° F., although, without apparent cause, it sometimes ranged from 98° F. to 103.5° F. It was not found, however, that inoculating the animals with the virus of spotted fever influenced in any way the range of temperature.

The following table shows the results of inoculating the coyotes with the virus of spotted fever and the subsequent injection of their blood into guinea pigs:

No. of coyote.	Quantity of virus injected.	Duration from date of inoculation.	No. of guinea pig.	Quantity of blood injected.	Result in guinea pig.
	c. c.	*Days.*		*c. c.*	
1	5	7	73	3.0	Died second day, peritonitis.
			74	2.0	Died sixth day, peritonitis.
		9	111	1.0	Died fifteenth day, pericarditis and peritonitis.
			112	2.0	Negative.[1]
2	10	5	134	2.0	Do.
			135	1.0	Do.
		8	142	1.0	Do.
		12	160	.75	Do.
3	5	6	136	2.0	Do.
			137	1.0	Do.
		9	143	1.5	Died second day, peritonitis.
			144	.5	Died third day, peritonitis.
		13	161	.....	Negative.
4	3	5	380	.25	Do.
			381	.75	Do.
5	2	5	182	.25	Do.
			183	.75	Do.

[1] Negative means that the pig did not develop spotted fever as a result of its injection with coyote blood, but did develop it when, about a month later, it was given the immunity test.

The above tests did not show the coyote to be susceptible to infection with spotted fever. While it could not be proven that these coyotes had not previously had spotted fever, it is not likely that they had, as they were caught during the winter when they were yet very small.

THE DOMESTIC CAT (FELIS DOMESTICUS).

The susceptibility of the cat was tried in four cases. As the cats that were used all came from the District of Columbia they undoubtedly had never been exposed to spotted fever infection. They were inoculated intraperitoneally with virus and after definite periods of incubation, inoculations of their blood were made into guinea pigs. The temperature of the cats, which was taken daily for 14 days after they were inoculated, was found to range from 100 F. to 102.6 F. The cats showed no evidences of being sick at any time during the experiments. The blood of the cat was found to be more or less toxic for guinea pigs, and consequently several of the guinea pigs died in from two days to two or three weeks after they were inoculated. Their temperature curves were not at all characteristic of spotted fever and the necropsies usually showed the presence of peritonitis, pneumonia, pericarditis, or a similar condition, but no lesions of spotted fever. Further injection of their blood into fresh guinea pigs usually killed within two or three days.

The results of the experiments are shown in the following table:

No. of cat.	Quantity of virus injected.	Duration from date of inoculation.	No. of pig.	Quantity of blood injected.	Result in guinea pigs.
	c. c.	*Days.*		*c. c.*	
		5	349	0.5	Died of pneumonia on third day.
1	1	5	350	.5	Died fifteenth day; leisons of peritonitis; none of spotted fever.
		8	367	.5	Died sixth day, of fibrinous pneumonia.
		5	351	.75	Died twenty-third day; pneumonia and pericarditis; no lesions of spotted fever.
2	2	5	352	.25	Negative; immunity test positive; recovered.
		8	368	.5	Do.
		5	353	.5	Do.
3	2	5	354	.5	Negative; immunity test positive; died.
		8	369	.5	Do.
		5	355	.5	Died fifth day of pneumonia.
4	3	5	356	.5	Died sixteenth day, peritonitis; no lesions of spotted fever.
		8	370	.5	Died second day, peritonitis.

These experiments do not show the cat to be susceptible to infection with spotted fever, neither do they prove that it is impossible to infect the cat although it is very probable that if it can be done at all it will be only in a small percentage of cases. It is, therefore, very unlikely that the cat is in any way instrumental in spreading spotted fever except that it may possibly act as an agent for carrying ticks into dwelling houses.

THE WEASEL (PUTORIUS ARIZONENSIS).

Only two weasels that were in a physical condition suitable for experimental purposes were obtained. They were both trapped in the infected district. Their susceptibility to spotted fever infection was tested in the usual way.

Weasel No. 1 was inoculated intraperitoneally with 1 c. c. of virus at which time the temperature of the animal was 101.4 F. while on successive days it was 104, 103, and 98.6 F. The animal was found

dead on the fifth day following its inoculation and 0.5 c. c. of its blood was then given to guinea pig No. 70. This guinea pig died of spotted fever within 12 days. Two days before this guinea pig died 0.5 c. c. of its blood was given to guinea pig No. 148 which also developed a typical case of spotted fever but recovered.

Weasel No. 2 was inoculated intraperitoneally with 0.75 c. c. of virus, and on successive days its temperature was 104.2, 105.7, 104, and 104.3 F. On the fourth day after the weasel was inoculated 0.5 c. c. of its blood was given to guinea pig No. 168. This guinea pig, unfortunately, died of peritonitis on the fifth day following its injection. It was therefore impossible to say whether or not this guinea-pig was infected with spotted fever. The inoculation of its blood into a fresh guinea pig would also no doubt have caused its death. Ten days after the weasel was inoculated with the virus 0.75 c. c. and 1 c. c. of blood were withdrawn from the animal's heart and injected into guinea pigs Nos. 170 and 171, respectively. The weasel died from the operation. Neither of the guinea pigs ran the temperature or otherwise presented any symptoms of spotted fever in the guinea pig. Guinea pig No. 170 became very much emaciated and died four weeks after it was injected and before it was given the immunity test. Guinea pig No. 171 was given the immunity test from which it developed spotted fever and died.

It will thus be seen that the blood of weasel No. 1 was ineffective for a guinea pig on the fifth day of the weasel's inoculation, while the results with weasel No. 2 were negative in so far as the experiment was carried, but were not conclusive.

At necropsy there were no lesions of spotted fever apparent in either one of the weasels.

From the above it is evident that the weasel is susceptible to experimental infection with spotted fever. Further work, however, will be done along this line next year.

THE TREATMENT OF SPOTTED FEVER IN ANIMALS.

From the view point of the inhabitants of the Bitter Root Valley the treatment of spotted fever ranks in importance second only to the eradication of the disease. Their desire is for a remedy with which human cases of the disease may be successfully treated. This, of course, is quite natural, particularly when the high mortality rate of the disease there is taken into consideration.

Ricketts and his associates did considerable work trying to produce, from the horse, a curative serum for the disease. They obtained a serum that undoubtedly had some protective powers, and although it was given only a limited trial in the treatment of human cases of spotted fever, the results obtained were not encouraging as to its efficiency in the treatment of the disease.

Since Ricketts's death Heinemann and Moore[1] have continued the work and have been able to produce a serum that has a high protective power for guinea pigs. It has been used in the treatment of human cases of spotted fever, but not yet to an extent to justify any deductions as to its value in the treatment of the disease. It probably exerts a beneficial effect at least when given early in the disease.

[1] Heinemann, P. G., and Moore, J. J., Jour. Am. Med. Assn., Chicago, 1911, Vol. LVII, p. 198.

Dr. Karl Kellogg, of Stevensville, Mont., used sodium cacodylate, apparently with good results, in the treatment of two cases of spotted fever during the summer of 1911. One of the cases, however, was treated with serum before the treatment with sodium cocodylate was begun.

Encouraged by Kellogg's results, and considering that there are some indications pointing to the infection of spotted fever being protozoal in character, the treatment of spotted fever in guinea pigs and rhesus monkeys with certain drug preparations, particularly the arsenic compounds, was taken up at the Hygienic Laboratory. The drugs used were salvarsan (606), sodium cacodylate, and urotropin. The animals were inoculated with the virus of spotted fever, blood from a monkey sick with that disease being used for the purpose. Blood of the monkey was used because it was feared that the blood of the guinea pig might be more or less toxic for monkeys. The blood was aseptically withdrawn from the monkey's heart and defibrinated. In order to test the prophylactic powers of the drugs, the treatment of some of the animals was begun at the time they were given the virus and before the symptoms of the disease appeared. Usually, however, the treatment was begun when the temperature of the animal began to rise, about the third day following inoculation. The treatment was administered to the monkeys intravenously, through the vein of the hind leg, and to the guinea pig intramuscularly and intravenously. The monkeys were injected intraperitoneally with 1.5 c. c. of virus and 2 c. c. of normal saline solution. The results with the different drugs used are given below.

THE TREATMENT OF MONKEYS WITH SALVARSAN.

Monkey No. 4.

On September 28, immediately after injecting the virus, the animal was given intravenously 0.1 gram of salvarsan in a 0.5 per cent solution. The salvarsan was given at this time in order to test its prophylactic powers. The temperature of the animal at 10 a. m. on the days following was: 104, 102.6, 103.6, 105.5, 105.1, 105, 104, 102.7° F. and death. The animal died on the tenth day, the necropsy showing typical lesions of spotted fever. There was marked redness of the face, buttocks, and extremities, and much hemorrhage under the skin over the entire body. The lymph glands in the groin, and the spleen, were typical of spotted fever.

Monkey No. 5.

The results of temperature, treatment, etc., are as follows:

September 28, monkey inoculated with virus.
September 29, 10 a. m., temperature 103.5° F.
September 30, 10 a. m., temperature 103.6° F.
October 1, 9.50 a. m., temperature 103° F.

Given intravenously 15 c. c. of a 0.5 per cent solution of salvarsan = 0.075 gram.

October 2, 10 a. m., temperature 103° F.
October 3, 10 a. m., temperature 103.6° F.

The dose of salvarsan as given October 1 was repeated.

October 4, 10 a. m., temperature 102.9° F.
October 5, 10 a. m., temperature 103.4° F.
October 6, 10 a. m., temperature 104.8° F.
October 7, 10 a. m., temperature 105.2° F.

Animal given 12 c. c. of 0.5 per cent solution of salvarsan = 0.06 gram.

October 8, 10 a. m., temperature 104.3° F.
October 9, 10 a. m., temperature 104.2° F.
October 10, 10 a. m., temperature 103.3° F.
October 11, 10 a. m., temperature 102.4° F.

The temperature continued at normal and the monkey recovered.

Monkey No. 6.

September 28, monkey inoculated with virus.
September 29, 10 a. m., temperature 102° F.
September 30, 10 a. m., temperature 103° F.
October 1, 10 a. m., temperature 103.2° F.

Given intravenously 20 c. c. of 0.5 per cent solution of salvarsan = 0.1 gram.

October 2, 10 a. m., temperature 102.2° F.
October 3, 10 a. m., temperature 103.6° F.

Given intravenously 22 c. c. of a 0.5 per cent solution of salvarsan = 0.11 gram.

October 4, 10 a. m., temperature 103.4° F.
October 5, 10 a. m., temperature 102.8° F.
October 6, 10 a. m., temperature 102.3° F.

On October 30 the monkey was given an immunity test with 1.5 c. c. of virus from which there was no reaction, the temperature being taken for 10 days.

Monkey No. 11.

October 14, monkey inoculated with virus.
October 15, 9.30 a. m., temperature 103.1° F.
October 16, 10 a. m., temperature 104.2° F.
October 17, 10 a. m., temperature 104.9° F.

From the monkey 0.5 c. c. of blood was taken and given to guinea pig No. 238, which developed spotted fever and died.

The monkey was given, intravenously, 12 c. c. of a 0.5 per cent solution of salvarsan = 0.06 gram.

October 18, 10 a. m., temperature 105° F.

The dose of salvarsan as given on the 17th was repeated.

October 19, 10 a. m., temperature 105.1° F.

The animal was given, intravenously, 6 c. c. of a 0.5 per cent solution of salvarsan = 0.03 gram.

October 20, 10 a. m., temperature 105.1° F.
October 21, 10 a. m., temperature 105.1° F.
October 22, monkey was found dead.

The necropsy showed the usual typical lesions of spotted fever.

The monkey died at 10.30 p. m.

The animal looked sick during the experiment, but there were no skin lesions of spotted fever apparent. At necropsy the animal was

found to have a well-developed case of tuberculosis. The axillary glands were caseous and the liver, spleen, pancreas, and kidneys the seat of miliary caseous abscesses. The inguinal glands were enlarged but not caseous. It is therefore impossible to say what part spotted fever played in causing the death of this monkey. An inoculation of a guinea pig was not made from the monkey.

Monkey No. 12.

October 14, the monkey was inoculated with virus.
October 15, 9.30 a. m., temperature 102.9° F.
October 16, 10 a. m., temperature 103° F.
October 17, 10 a. m., temperature 104.2° F.

From the animal 0.5 c. c. of blood was taken and given to guinea pig No. 239, which developed spotted fever and recovered.

The monkey was given intravenously 15 c. c. of a 0.5 per cent solution of salvarsan = 0.075 gram.

October 18, 10 a. m., temperature 104.8° F.
October 19, 10 a. m., temperature 104.7° F.

The dose of salvarsan as given on October 17 was repeated.

October 20, 10 a. m., temperature 103.4° F.
October 21, animal found dead.

The necropsy showed the lesions typical of spotted fever and pig No. 249, which was inoculated with blood from the monkey, died of spotted fever.

Monkey No. 13.

October 14, monkey inoculated with virus.
October 15, 9.30 a. m., temperature 102.2° F.
October 16, 10 a. m., temperature 103.1° F.
October 17, 10 a. m., temperature 104.9° F.

0.5 c. c. of blood from monkey was given to pig No. 240, which developed spotted fever (recovery).

Monkey was given 18 c. c. of a 0.5 per cent solution of salvarsan = 0.09 gram.

October 18, 10 a. m., temperature 104.4° F.
October 19, 10 a. m., temperature 104.9° F.

Monkey was given 15 c. c. of a 0.5 per cent solution of salvarsan = 0.075 gram.

October 20, 10 a. m., temperature 104.7° F.
October 21, animal found dead.

The necropsy showed the lesions typical of spotted fever, and pig No. 250, which was given 0.5 c. c. of blood from the monkey, developed spotted fever (recovery).

Control monkey No. 10.

This monkey was used as a control for monkeys Nos. 4, 5, and 6. They were all inoculated with virus in the same manner and at the same time on September 28. The control monkey was given no treatment.

Its temperature at 10 a. m. on September 29 and the days following was 102.8°, 102.8°, 102.6°, 105°, 104.9°, 105.5°, 105.7°, 104.6°, and death.

The necropsy showed the usual typical lesions of spotted fever.

Control monkey No. 16.

This monkey was used as a control for monkeys Nos. 11, 12, and 13, they all being inoculated with the virus on the same date and under the same conditions on October 14.

The temperature of this monkey at 10 a. m. on the day it was inoculated was 103.8° F., and on the following days it was 102.9°, 103.6°, 104.1°, 106°, 105°, 105.4°, 105°, and death.

This monkey ran a typical course of spotted fever and at necropsy showed the usual lesions of that disease.

THE TREATMENT OF GUINEA PIGS WITH SALVARSAN.

Guinea pigs were inoculated intraperitoneally with the virus of spotted fever and treated with a 0.5 per cent solution of salvarsan administered to them in different ways.

Guinea pigs Nos. 197 and 198 were given, intramuscularly in the left thigh, 0.025 and 0.03 gram, respectively, at the time they were inoculated with the virus. Both of these pigs ran marked courses of spotted fever with scrotal sloughing, but both of them recovered.

Guinea pigs Nos. 199, 200, and 201 were inoculated with the virus; and then three days later, when the temperature began to rise, they were given, intramuscularly in the left thigh, 0.025, 0.03, and 0.035 gram, respectively. These pigs died in 8, 5, and 7 days, respectively, with the symptoms and lesions of spotted fever.

As controls for the above, guinea pigs Nos. 207 and 208 were used, they simply being inoculated with the virus, but not treated in any way. They both died of spotted fever on the eighteenth and twelfth days, respectively.

Guinea pigs Nos. 221, 222, and 223, three days after they were inoculated with the virus, were injected through the jugular vein with 0.01, 0.015, and 0.015 gram, respectively. They died of spotted fever on the seventh, ninth, and eighth days, respectively.

Guinea pig No. 228 was used as a control for pigs Nos. 221, 222, and 223. It died of spotted fever on the tenth day following its inoculation with the virus of that disease.

THE TREATMENT OF MONKEYS WITH SODIUM CACODYLATE.

Monkey No. 7.

Immediately after inoculating the monkey with the virus of spotted fever on September 28 it was given, intravenously through a vein on the back of the hind leg, 6 c. c. of a 1 per cent solution of sodium cacodylate = 0.06 gram. The temperature of the monkey at 10 a. m. on the successive days was: 102.4°, 102.9°, 102.8°, 103.2°, 105.1°, 105.5°, 105.3°, 105.3°, 104.8°, 103.4°, and death. At necropsy the animal showed the usual typical lesions of spotted fever.

Monkey No. 8.

September 28, the monkey was inoculated with virus.
September 29, 10 a. m., temperature 101.8° F.
September 30, 10 a. m., temperature 103.1° F.
October 1, 10 a. m., temperature 103. 6° F.

Monkey was given, intravenously, 4 c. c. of a 1 per cent solution of sodium cacodylate = 0.04 gram.

October 2, 10 a. m., temperature 105.4° F.
October 3, 10 a. m., temperature 105.7° F.

Given, intravenously, 5 c. c. of a 1 per cent solution of sodium cacodylate = 0.05 gram.

October 4, 10 a. m., temperature 106.3° F.
October 5, 10 a. m., temperature 105.5° F.
October 6, 10 a. m., temperature 102.1° F.

Monkey was found dead in the cage at 2 p. m. The necropsy showed the lesions that are considered typical of spotted fever in the monkey.

Monkey No. 9.

September 28, the monkey was inoculated with virus.
September 29, 10 a. m., temperature 102.4° F.
September 30, 10 a. m., temperature 103.2° F.
October 1, 10 a. m., temperature 104° F.

Monkey was given, intravenously, 6 c. c. of a 1 per cent solution of sodium cacodylate = 0.06 gram.

October 2, 10 a. m., temperature 104.6° F.
October 3, 10 a. m., temperature 106° F.

Given, intravenously, 8 c. c. of a 1 per cent solution of sodium cacodylate = 0.08 gram.

October 4, 10 a. m., temperature 105.4° F.
October 5, 10 a. m., temperature 105.5° F.
October 6, 10 a. m., temperature 104.6° F.

The dose of sodium cacodylate as given on October 3 was repeated. October 7 the monkey was found dead in the cage and the necropsy showed the lesions characteristic of spotted fever in the monkey.

Monkey No. 10 was used as a control for monkeys Nos. 7, 8, and 9, all having been inoculated with the virus of spotted fever at the same time on September 28. For result with monkey No. 10, see page 750.

THE TREATMENT OF GUINEA PIGS WITH SODIUM CACODYLATE.

Guinea pigs were inoculated with the virus of spotted fever and treated with sodium cacodylate, using for the purpose a 1 per cent solution of the drug.

Guinea pigs, Nos. 202 and 203, immediately after they were given the virus, were injected in the muscles of the left thigh with 0.015 and 0.02 gram, respectively. Pig No. 202 ran a typical and severe course of spotted fever with sloughing of the scrotum and peeling of the ears, but recovered, while pig No. 203 died of spotted fever on the sixteenth day.

Guinea pigs, Nos. 204, 205, and 206, on the third day after they were inoculated with the virus, were injected subcutaneously with 0.015, 0.02 and 0.025 gram, respectively, and on the fifth day the dose in the case of each guinea pig was repeated. Guinea pigs Nos. 204 and 205 died of spotted fever on the tenth and ninth days, respectively, while pig No. 206 recovered after running a well-marked case of spotted fever.

Guinea pigs Nos. 207 and 208 were used as controls for the pigs treated with sodium cacodylate, the pigs all having been inoculated with the virus of spotted fever at the same time. For results with guinea pigs Nos. 207 and 208 see page 751.

THE TREATMENT OF MONKEYS WITH UROTROPIN (HEXAMETHYLENAMINE).

Two monkeys were treated with intravenous injections of urotropin. The drug being very soluble in water, a 25 per cent solution was made and then filtered through a Berkefeld filter before it was injected into the monkeys. By filtering the aqueous solution, a sterile preparation was obtained with which there was no danger of infecting the monkeys.

Monkey No. 14.

On October 14, the monkey was inoculated with the virus of spotted fever and immediately thereafter it was injected intravenously with 8 c. c. of a 25 per cent solution of urotropin = 2 grams. The monkey was given this same size dose of urotropin each day until October 22, on which date the animal was found dead in the cage. The temperature of the monkey on the days following its inoculation with virus was: 103.3°, 102.3°, 102.7°, 105.6°, 105°, 104.8°, and 104.8° F.

Three days after the monkey was inoculated with the virus, 0.5 c. c. of its blood was given to guinea pig No. 241 which developed spotted fever and recovered. The necropsy of the monkey showed the usual lesions of spotted fever.

Monkey No. 15.

October 14 the monkey was inoculated with virus.
October 15, 10 a. m., temperature 102.5° F.
October 16, 10 a. m., temperature 103.2° F.
October 17, 10 a. m., temperature 105.3° F.

0.5 c. c. of blood from the monkey was given to guinea pig No. 242, which developed spotted fever and recovered.

The monkey was injected intravenously with 12 c. c. of a 25 per cent solution of urotropin = 3 grams.

October 18, 10 a. m., temperature 105.6° F.

The dose of urotropin as given on October 17 was repeated.

October 19, 10 a. m., temperature 104.7° F.
October 20, 10 a. m., temperature 104.6° F.

The dose of urotropin as given on October 18 was repeated.

October 21, 10 a. m., temperature 105.3° F.

The dose of urotropin as given on October 20 was repeated.

October 22 the animal was found dead. The necropsy showed the lesions that are typical of spotted fever in the monkey.

As a control for monkeys Nos. 14 and 15, monkey No. 16 was used, see page 751.

THE TREATMENT OF GUINEA PIGS WITH UROTROPIN.

Only two guinea pigs, Nos. 224 and 225, were treated with urotropin. Beginning on the third day after the guinea pigs were inoculated with the virus, they were treated on successive days with subcutaneous injections of urotropin as follows: Guinea pig No. 224 was given 1.5 grams, 0.75 gram, 1 gram, and 1 gram, while guinea pig No. 225 was given 2 grams, 0.75 gram, 1 gram, and 1 gram. Both pigs died of spotted fever on the ninth day after they were inoculated with the virus of that disease. As a control, guinea pig No. 228 was used (see p. 751).

The following table will show the results of the treatment of the monkeys with salvarsan, sodium cacodylate, and urotropin:

No. of monkey.	Treated with—	Result.
1	Not treated	Died on eighth day.
2	.....do	Died on ninth day.
3	.....do	Do.
4	Salvarsan	Died on tenth day.
5	.....do	Recovered.
6	.....do	Died on eighth day.[1]
7	Sodium cacodylate	Died on tenth day.
8	.....do	Died on eighth day.
9	.....do	Died on ninth day.
10	Control for Nos. 4 to 9	Do.
11	Salvarsan	Died on eighth day.
12	.....do	Died on seventh day.
13	.....do	Do.
14	Urotropin	Died on eighth day.
15	.....do	Do.
16	Control for Nos. 11 to 15	Do.

[1] This monkey was found at necropsy to have a well-advanced case of tuberculosis.

It will readily be observed that the results obtained above in the treatment of spotted fever in monkeys and guinea pigs with the different drug preparations that were tried are by no means encouraging in so far as the successful treatment of that disease is concerned. In fact, the administration of the drugs seems, on the whole, as compared with the controls which received no drug treatment at all after being inoculated with the virus of spotted fever, to have hastened the death of most of the animals that were treated. Of the 10 monkeys that were treated, only 1 recovered. That one was treated with intravenous injections of salvarsan. The chances of finding a specific remedy for the treatment of spotted fever seem rather remote. Possibly, if the specific organism of that disease can be identified and isolated, a remedy for the disease may be procured. However, in this connection it must be borne in mind that there are already quite a number of diseases, the causative organisms of which are well known, but for which no specific remedies have yet been prepared.

SUMMARY AND REMARKS.

In the work on Rocky Mountain spotted fever which was begun on May 26, 1911, an infected district of about 8 square miles was selected, on which a concrete dipping vat was constructed, the dipping of domestic stock was begun, and considerable headway was made in destroying the wild mammals in the infected district that was selected for demonstrative purposes. The number of small wild mammals killed, by shooting and trapping, and collected was 3,465, of which

3,233 were ground squirrels. This does not include the number killed with poison or carbon bisulphide.

A search was made for the infection of spotted fever among the ground squirrels in nature, the results of which were negative.

The susceptibility to experimental infection with spotted fever was studied in the cases of 25 ground squirrels caught at random in the infected district. They were inoculated with the virus of spotted fever and subsequent inoculations of their blood made into guinea pigs. As shown by the results in the guinea pigs, 23 of the ground squirrels were positively infected with spotted fever, one of them was probably infected, while the results with 1 squirrel, the blood of which was injected into a guinea pig on the second day following its inoculation, was negative. In all probability this negative result was due to the early date in the period of incubation at which the blood was transferred from the ground squirrel to the guinea pig.

There is, therefore, no positive evidence that any of the 25 ground squirrels were immune to spotted fever. As these ground squirrels all came from an infected territory and assuming that one attack of spotted fever in the ground squirrel renders that animal immune to further infection with that disease these results tend to minimize the probability of the ground squirrel actually playing a part in the spread of spotted fever. Further work with ground squirrels from other infected territories will be done in order to determine whether or not immune ground squirrels can be found existing in nature.

Out of a total of 4 badgers that were experimented with only one of them was found susceptible to infection with spotted fever, and of 5 guinea pigs that were inoculated with blood taken from this badger at three different times only one of them developed spotted fever. Provided that none of these badgers had an acquired immunity at the time they were experimented with, and it does not seem likely that they did, the badger is evidently only very slightly susceptible to experimental infection with spotted fever and very probably plays no part in the spread of the disease.

The results with experiments of infecting 5 coyotes and 4 domestic cats were negative. It is not thought that either one of these animals has any thing to do with the spread of spotted fever except that the cat may possibly carry infected ticks into dwelling houses.

Only two weasels were experimented with, one of which was experimentally infected with spotted fever while the results obtained in the case of the other were negative but not conclusive. Although the weasel was found to be susceptible to infection, further work along this line will be done this year.

Rhesus monkeys and guinea pigs were infected with spotted fever and treated with different drug preparations, namely, salvarsan, sodium cacodylate, and urotropin. The results obtained, however, do not indicate that any of these drugs possess any value whatever either as a prophylactic or in the treatment of spotted fever, but on the contrary their administration seems on the whole rather to intensify the severity of the disease in the animals as compared with the course of the disease in the controls.

The work on spotted fever will be again taken up early in the season of 1912 when the tick and the ground squirrel first make their appearance, it having been begun too late in 1911 to accomplish a great deal. The work will be continued on the same lines along

which it was carried on in 1911. The dipping of domestic stock and the destruction of wild mammals in the selected district will be thoroughly carried out in order to determine the result that these measures may have in eradicating the tick from the district. There is no doubt that the domestic animals are a source of food for a great many adult ticks. However, the hope of completely eradicating them by dipping the domestic stock is rather discouraged by information obtained from reliable inhabitants to the effect that although the number of domestic animals has been greatly reduced in certain localities during past years the number of ticks has by no means been proportionately reduced.

Furthermore, the tick is found rather abundantly in places in the mountains at high altitudes and in localities that are practically never frequented by domestic stock. That the tick can be practically eradicated from the infected districts or even from the whole valley there is no doubt, but it will entail considerable cost and labor to do so. In this connection it may be remarked that the statement by Hunter and Bishopp [1] to the effect that the practical eradication of the spotted-fever tick from the Bitter Root Valley can be accomplished in three seasons for the approximate sum of $23,692, and that after that time the prevention of reinfestation of the valley can be easily accomplished by employing an inspector for six months' service each year is somewhat more optimistic than the facts would seem to warrant.

The dipping of domestic stock, the destruction of wild mammals, and the clearing and burning over of land are all excellent methods for eradicating the tick. The exact extent to which the dipping of domestic stock alone will eradicate the tick is as yet more or less problematical but as soon as the efficiency of the different methods, either singly or together, can be demonstrated to the ranch owners and inhabitants they will no doubt give their hearty cooperation and utmost assistance in carrying on the work and furthering its success.

There is urgent necessity for a State law under which the dipping of stock in infected districts can be enforced. It should require the dipping of all stock in territories declared by the State board of health or its secretary to be infected. Experience has shown that most of the stock owners want their stock dipped, but some of them insist on waiting until it suits their own convenience to have it done, while a small percentage of them object, for one reason or another, to having anything done. They thus handicap the work and this should not be permitted in a condition as serious as spotted fever, and where most of the stock owners are anxious to cooperate in stamping out the disease.

A State law should also be passed requiring property owners to make a reasonable effort to exterminate the rodents on their property.

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